Centennial Valley Arctic Grayling Adaptive Management Project

30 August, 2018

Our Goal

- A glacial relict population of Arctic grayling (*Thymallus arcticus*) once existed throughout the upper Missouri River (UMR) drainage, but declined to $\approx 4\%$ of their historic distribution by the 1990s.
- One of the last populations of indigenous grayling in the UMR resides in the Centennial Valley (CV) of southwestern Montana.
- The conservation goal for Montana Arctic grayling is to "*Ensure the long-term, self-sustaining persistence of Arctic grayling in the upper Missouri River Basin*".
- Maintaining a spawning population of ≥ 1000 grayling in the upper CV has been identified as a key strategy for achieving the overall conservation goal.

Our Approach

- The Centennial Valley Arctic Grayling Adaptive Management Plan (AMP) is being implemented to identify the most effective management strategies to maintain at least 1000 spawning fish in the upper CV grayling population. Non-native hybrid Yellowstone cutthroat trout, spawning habitat, and overwinter habitat have been identified as the three most likely factors that could limit long-term viability of upper CV grayling. A population model representing each hypothesized limiting factor was created; learning occurs through the comparison of annual model predictions of grayling abundance to estimated grayling abundance (Table 1).
- An emphasis on learning through 'management as experiment' is being accomplished during the first phase of the AMP via two experiments that 1) reduced non-native hybrid Yellowstone cutthroat trout population (2013–2016) and 2) will maximize availability of spawning habitat (2017–2020). No experiments have been planned for altering winter habitat; natural variability has been sufficient to explore the hypothesized relationship between grayling spawning population and area of suitable winter habitat in Upper Red Rock Lake (Upper Lake).

Outcomes

- The estimated number of Arctic grayling in the 2018 Red Rock Creek spawning population was **387 (95% CI = 168–682**), nearly unchanged from the prior year ($\hat{N} = 176$, 95% CI = 159–213; Figure 1).
- The estimated number of Yellowstone cutthroat trout in the Red Rock Creek spawning population was **916**, an approximate reduction of **72%** from the highest estimated population in 2014 ($\hat{N} = 3282$; Figure 1).

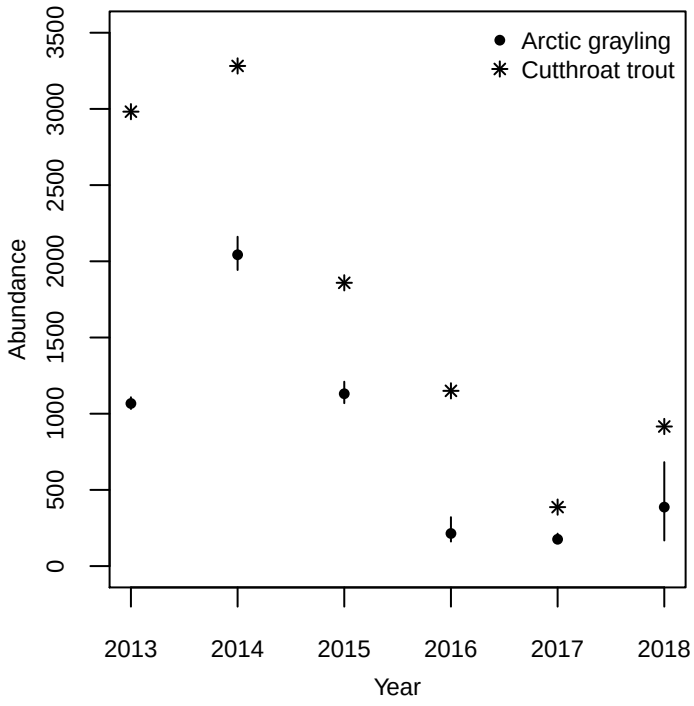

Figure 1. Arctic grayling and non-native hybrid Yellowstone cutthroat trout abundance estimates and 95% confidence intervals (grayling only) from Red Rock Creek, 2013–2018.

- Suitable winter habitat within Upper Lake (i.e., water depth below the ice $\geq$ 1 m and dissolved oxygen $\geq$ 4 ppm) reached a minimum during February 2018 sampling at an estimated 19 ha. Grayling spawning population was reduced to $\leq$ 214 fish in all years when <10 ha of suitable winter habitat was available in Upper Lake (Figure 2).

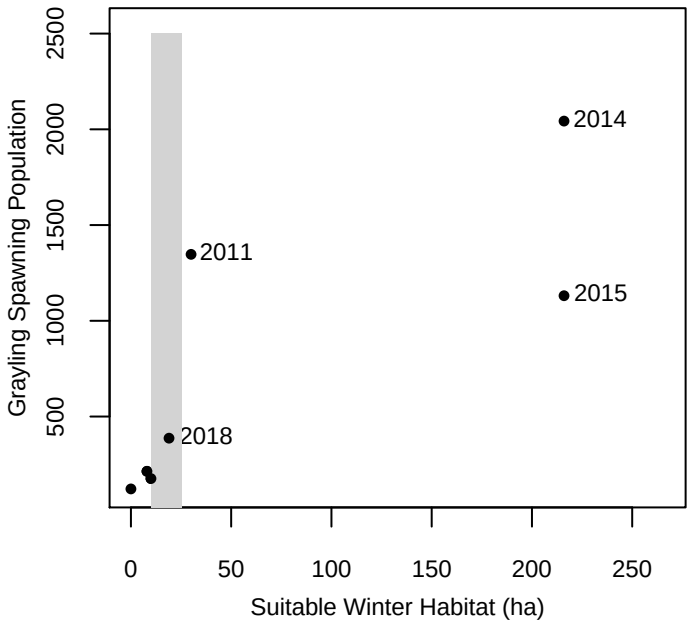

Figure 2. Arctic grayling spawning population as a function of minimum area of suitable winter habitat for years when both were estimated (1995 [0 ha], 2016 [8 ha], and 2017 [10 ha] points are plotted but not labelled). The shaded polygon represents an hypothesized threshold (10–25 ha) of suitable winter habitat where 1) enough winter habitat is available to sustain grayling population at objective ($N \geq 1{,}000$ fish, $>$ 25 ha suitable habitat), and 2) winter habitat presumably reduces grayling survival, resulting in grayling population below objective ($\hat{N} \leq 214$, <10 ha suitable habitat).

- Suitable spawning habitat was most recently quantified in 2017, with an estimated total area of suitable spawning habitat (A_{ts}) of 0.1 ha, and weighted area of suitable habitat (A_{tw}) of 4 ha, in Red Rock and Elk Springs creeks. Surveys to estimate area of suitable spawning habitat will be completed again in 2019.
- The *Winter Habitat*, *Spawning Habitat*, and *Non-native Fish* models predicted 67, 217, and 840 grayling, respectively, in the 2018 Red Rock Creek spawning population. The *Winter Model* continued to predict grayling spawning population more precisely than the other models (Table 1), providing support for overwinter habitat in Upper Lake being a primary driver of grayling abundance in the upper CV.

Table 1. Arctic grayling spawning abundance model predictions, observed abundance, and relative model weights for 2018. Model weights, which sum to 1, are a measure of relative support for a model given the data.

Model	2018 Prediction	Observed	Model Weights
Winter Habitat	67	387	0.555
Spawning Habitat	217	387	0.347
Non-native Fish	840	387	0.097

- Management actions to assess the effect of spawning habitat on grayling abundance were initiated in 2017 and continued this year. Spawning habitat was maximized by 1) restoring connectivity to, and habitat within, Elk Springs Creek, and 2) providing access to all spawning habitat in Red Rock Creek by breaching beaver dams ($n = 48$).
- No management actions to improve winter habitat are presently identified or planned. However,

the recent restoration of Elk Springs Creek to improve spawning habitat may also improve winter habitat in Upper Lake by allowing the creek to largely circumvent Swan Lake, increasing the flow of highly-oxygenated water into Upper Lake. Based on four years where winter habitat and grayling spawning population were estimated, a threshold level of 10–25 ha of winter habitat appears necessary to overwinter grayling populations greater than the 1,000 fish objective (Figure 2).

- A decision table will be used to evaluate consequences of management actions for achieving the upper CV grayling population objective. Predicted abundance from each combination of management action and model will be used to estimate a model-weighted grayling abundance to determine the best management action given the current state of knowledge.